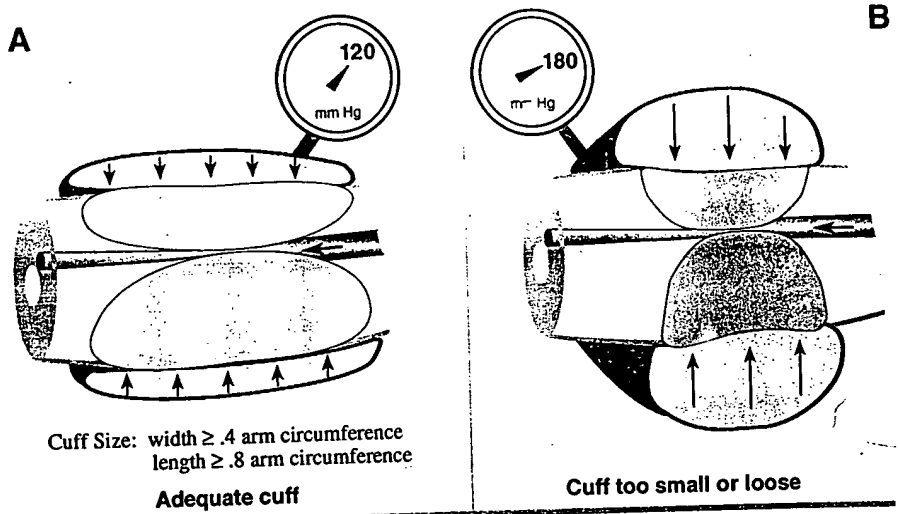
Measurement of Arterial Blood Pressure



Blood and cuff pressures (sloping lines) during blood pressure determination. Dots indicate points at which K sounds are present

Jones/Thornton 1997

FIG. 1

Arterial Pulse/BP, (Proximal Aorta)

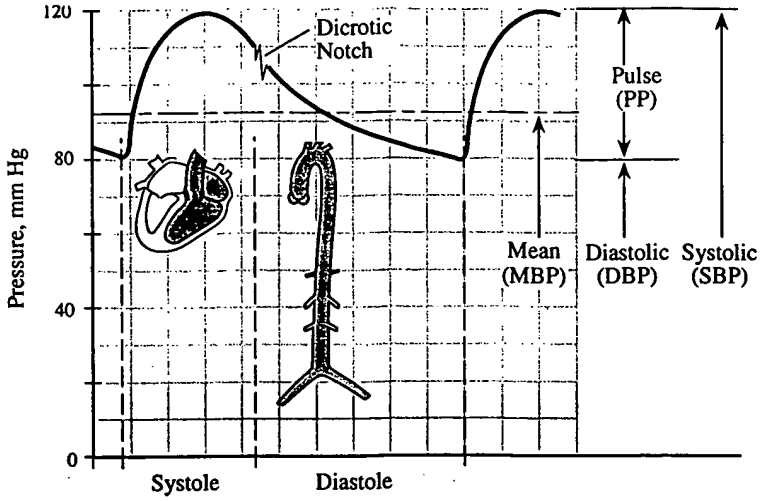
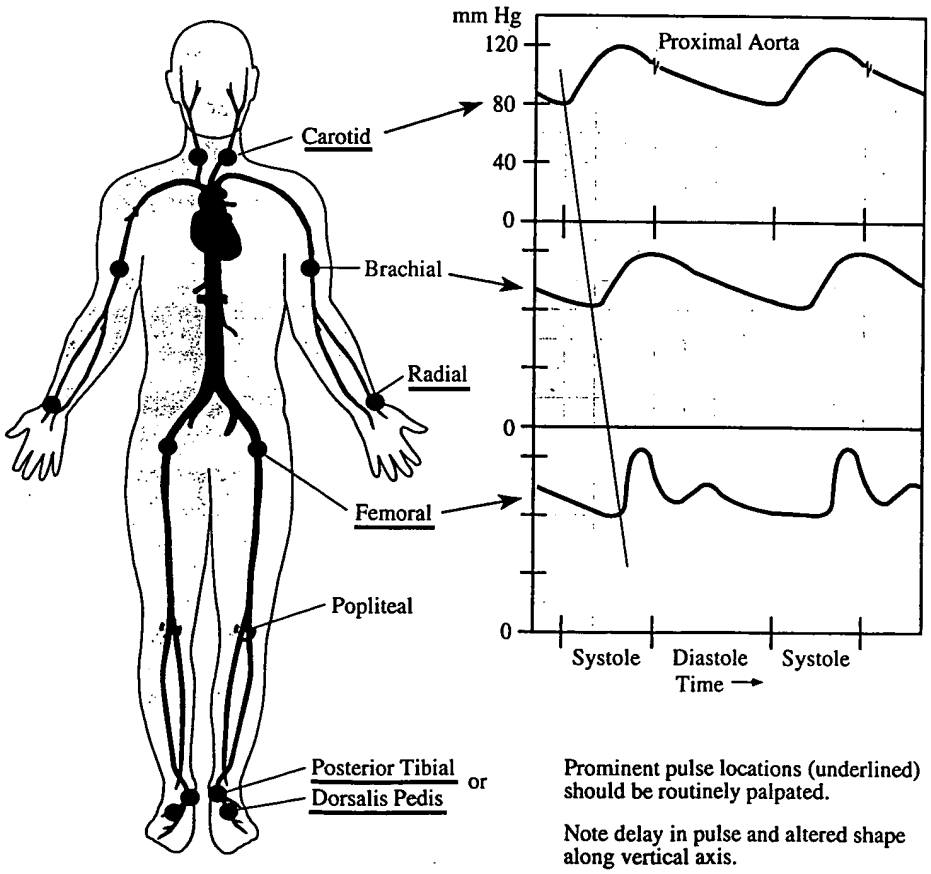


FIG. 2

Peripheral Pulses

Pulse Rate = pulses / 60 sec

Normal: 72 +8 Tachycardia
-14 Bradycardia



Right = Left

Prominent pulse locations (underlined) should be routinely palpated.

Note delay in pulse and altered shape along vertical axis.

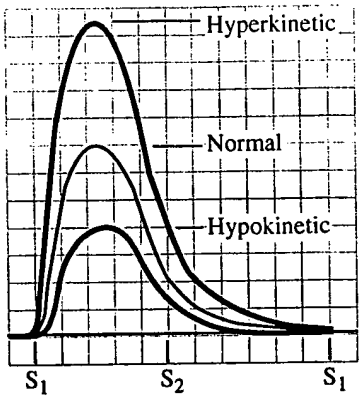
Pressure-waveforms in supine position

FIG. 3

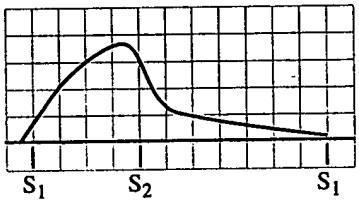
Contour of Carotid Pulse and Cardiac Impulse

A. Carotid Pulses

1.

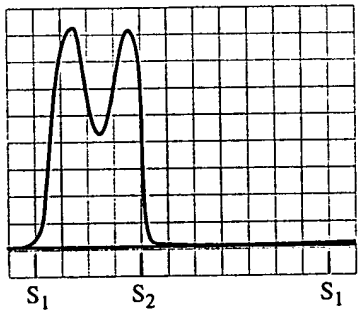


2.



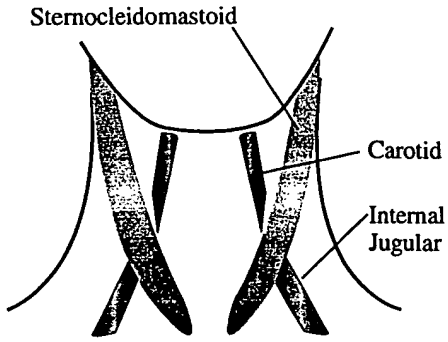
Parvus et tardus (weak and slow) pulse of aortic stenosis or other outflow obstruction

3.



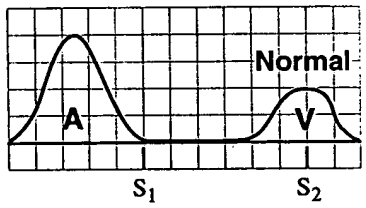
Bifid pulse

B. Location of carotid and jugular pulses

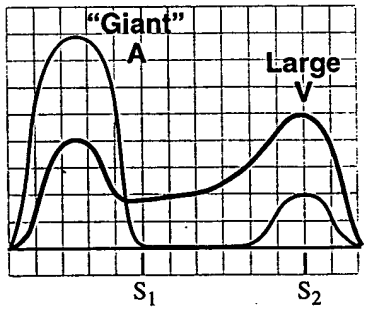


C. Jugular Venous Pulses

1.

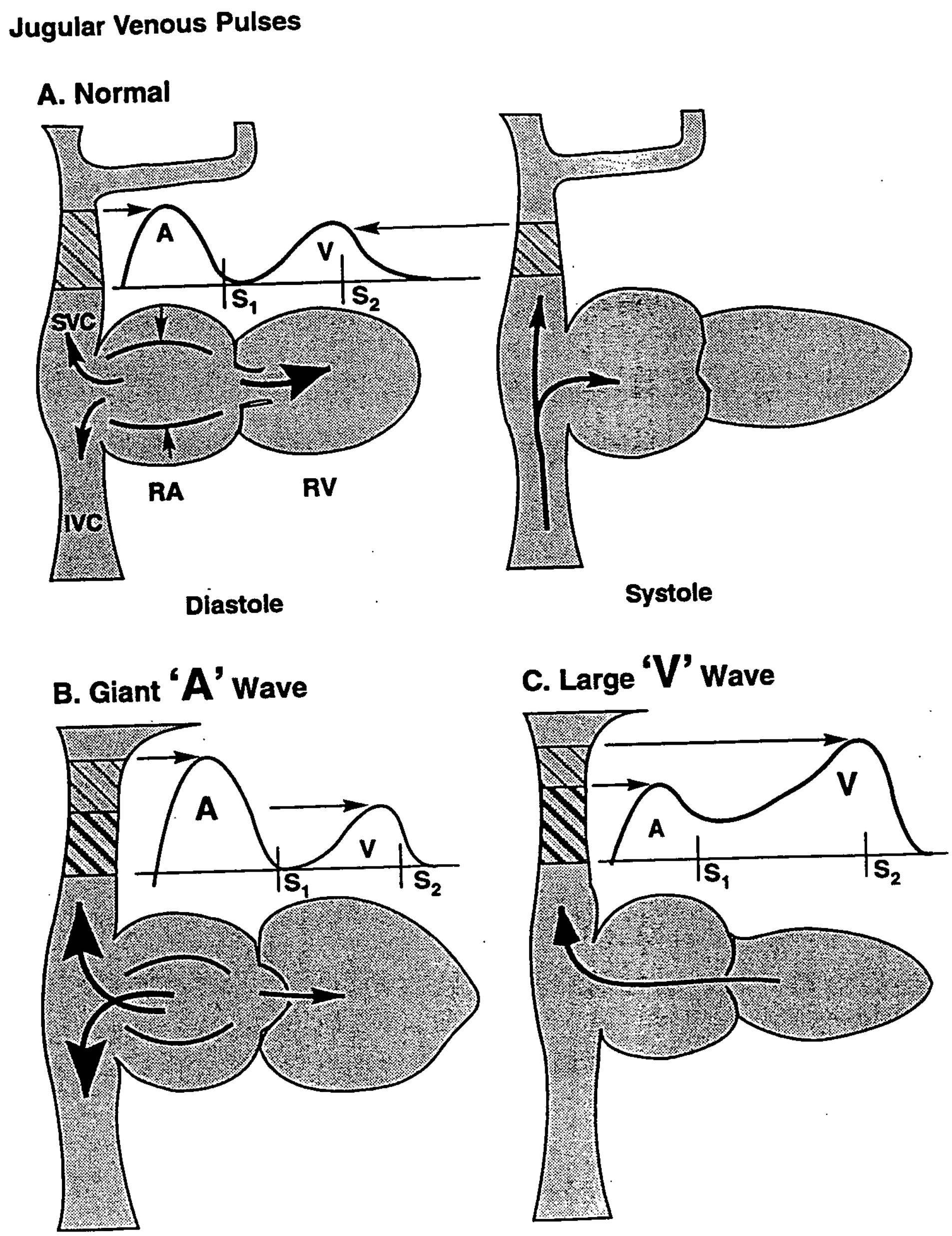


2.



Jones/Thornton 1997

FIG. 4



Jugular Venous Pulses
A. Normal
A
V
S1
S2
SVC
IVC
RA
RV
Diastole
Systole
B. Giant 'A' Wave
A
V
S1
S2
C. Large 'V' Wave
V
A
S1
S2

FIG. 5

Determination of Right Atrial Mean Pressure

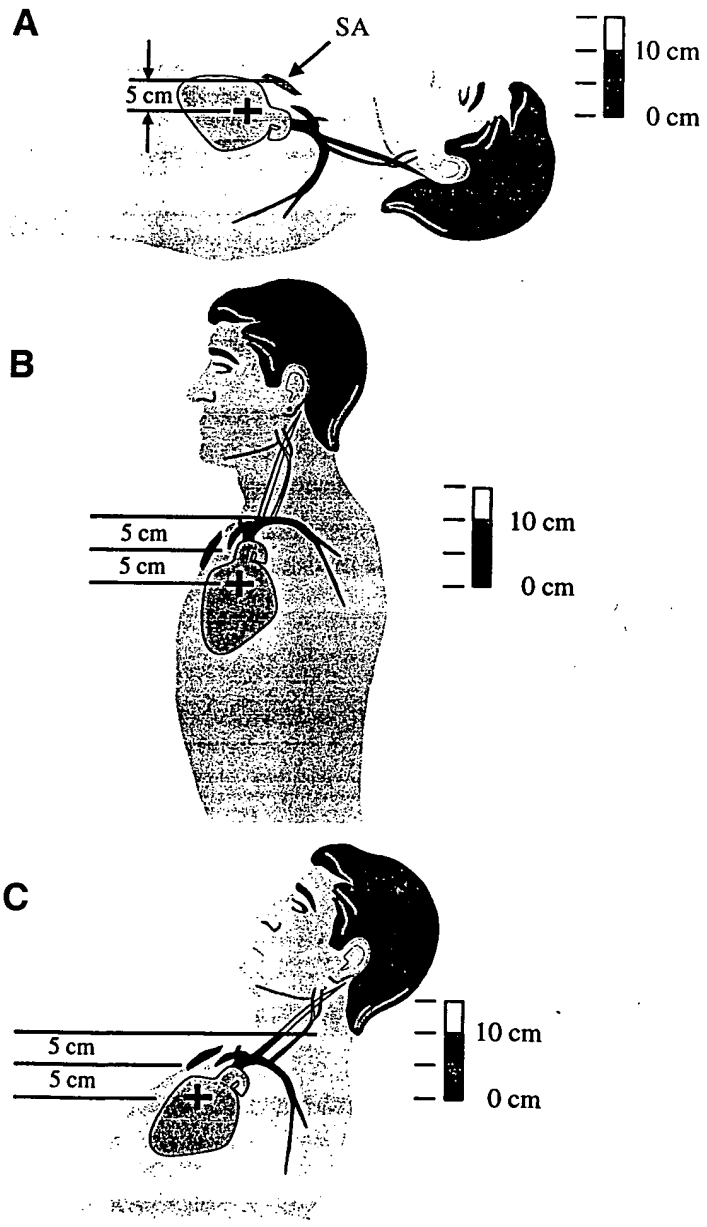
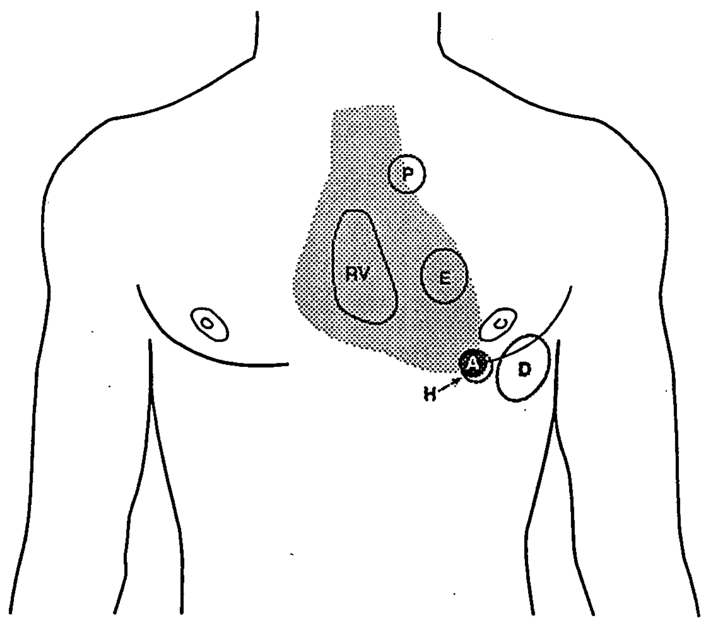


FIG. 6

Principal Areas of Cardiac Impulses



(A) Normal left ventricular apical area, "dime sized," 5LICS–MCL

(H) "Hypertrophied" left ventricular apical area, "quarter sized," may be *slightly* shifted inferiorly or laterally

(D) "Dilated" left ventricular apical area, marked size increase, shifted laterally

(E) Ectopic area of left ventricle

(P) Pulmonic area, 2LICS, parasternal

(RV) Right ventricular area along lower left sternal border

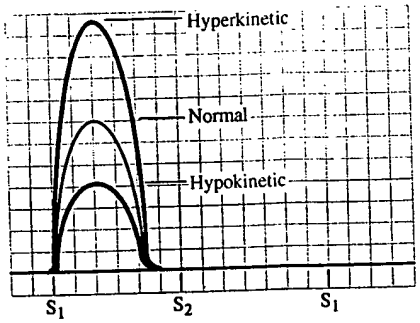
Primary areas of precordial pulsation: As you progress you will find that additional areas of abnormal pulsation may occasionally be found.

FIG. 7

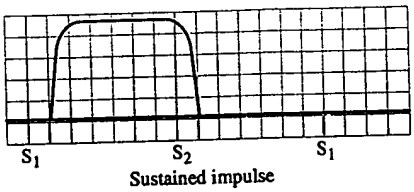
Contour of Precordial Ventricular Impulses

Precordial Impulses

1.

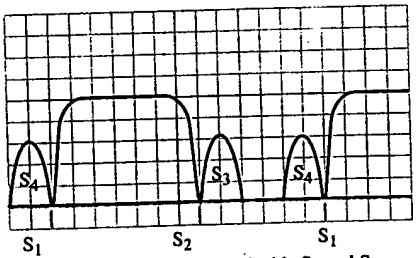


2.



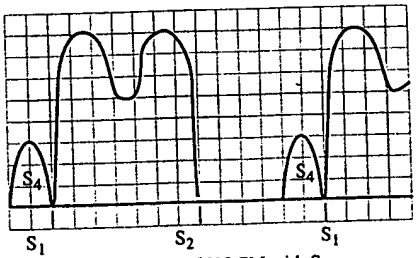
Sustained impulse

3.



Sustained impulse with palpable S_3 and S_4
(which usually occur singly)

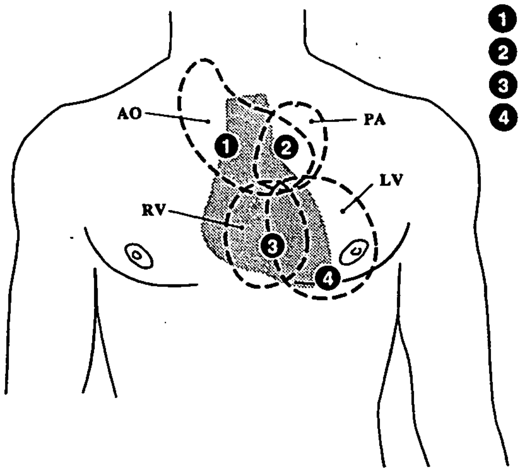
4.



Bifid impulse of HOCM with S_4
("triple ripple")

FIG. 8

Primary Areas for Cardiac Auscultation



1. Aortic Area (2RSB)
2. Pulmonic Area (2LSB)
3. Tricuspid Area (4LSB)
4. Mitral, (Apical) Area (5LICS, MCL)

As you progress you will find that additional areas are necessary in cardiac auscultation.

Optimum locations for auscultation of the various anatomic regions are shown in numbered circles. Typical extent of the sounds from various areas are shown by dotted lines. This extent will vary with pathology and some sounds and murmurs may "radiate" to other areas such as the left axilla in mitral regurgitation. Sounds from the aorta, pulmonary artery and left atrium may be heard well or even best over the posterior upper thorax as shown.

FIG. 9

Perceived Loudness of Heart Sounds and Quiet Speech at Same Sound Level (~50 dB SPL)

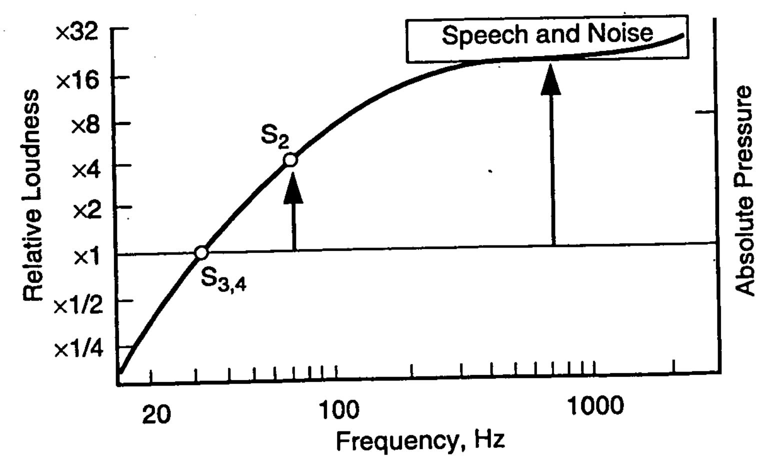
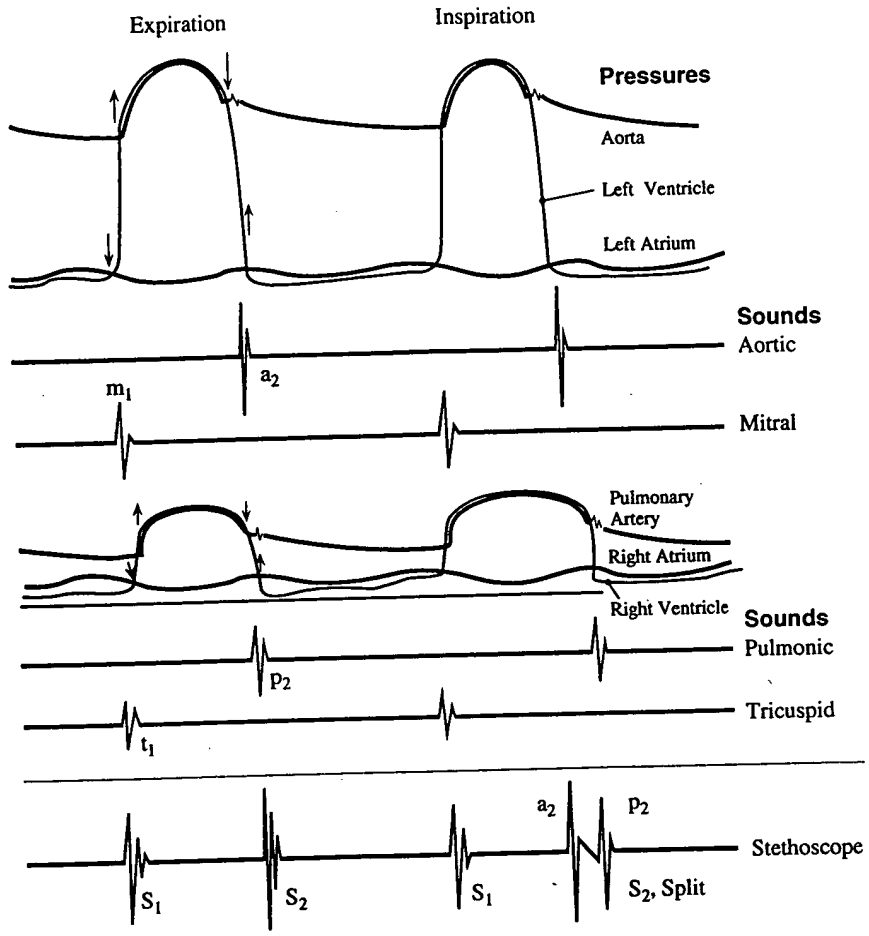


FIG. 10

Generation of Normal Heart Sounds, S_1, S_2



Normal valves open silently, indicated by ↑. Closing times, indicated by ↓, of mitral and tricuspid valves are typically so close that their individual sounds, m_1 and t_1, merge to form S_1. On expiration the same is true for aortic and pulmonic valves and their sounds, a_2 and p_2. With increased negative intrathoracic pressure on inspiration the right heart increases its volume and blood is retained in the lungs, reducing left heart volume. Consequently closure of the pulmonic valve is delayed by ejection of the larger volume while aortic valve closure occurs earlier than normal, thus "splitting" the usually merged second heart sounds. Respiratory splitting of the second heart sound occurs in some 30% of normal youth, but its prevalence is reduced by age until it is normally absent by age 60.

FIG. 11

Normal Heart Sounds vs. Auscultatory Areas, Typical

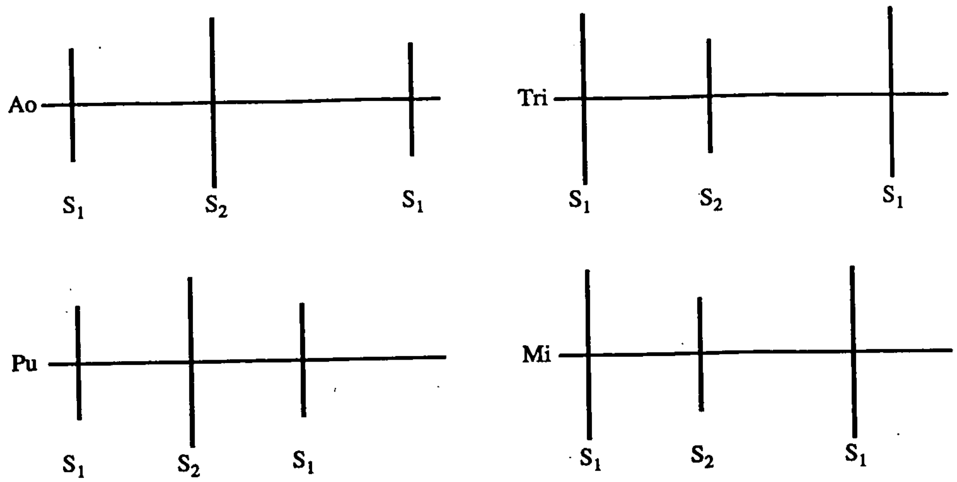
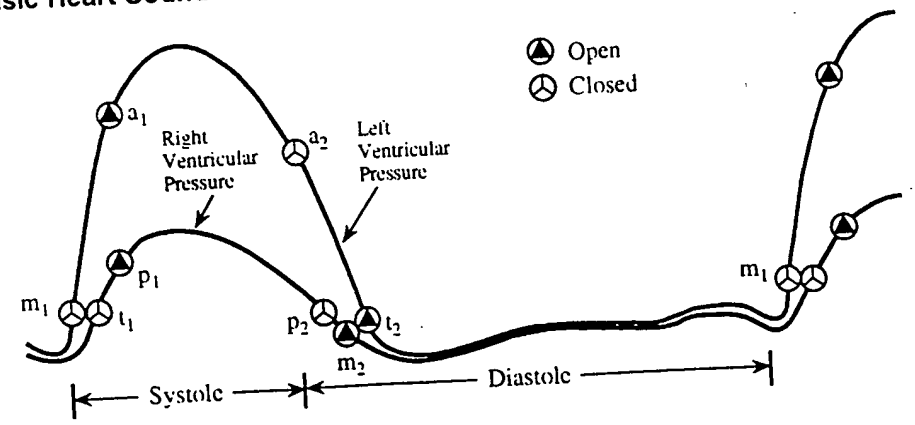
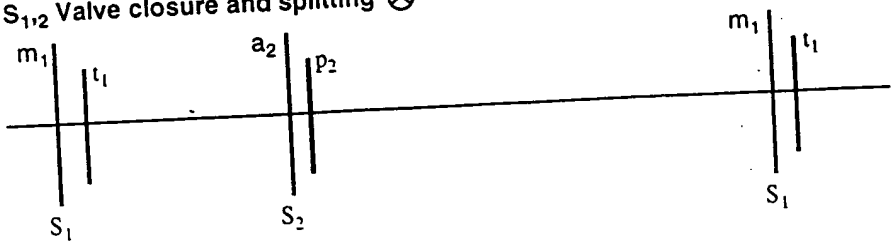


FIG. 12

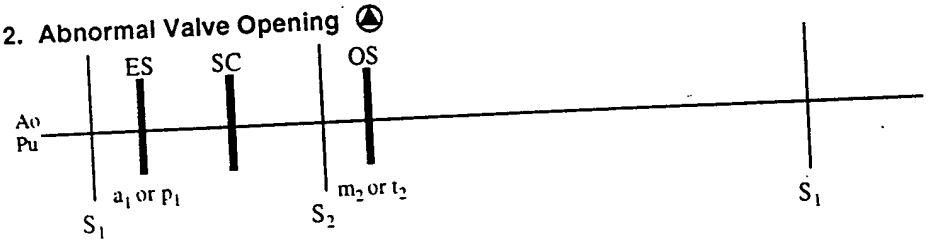
Basic Heart Sounds



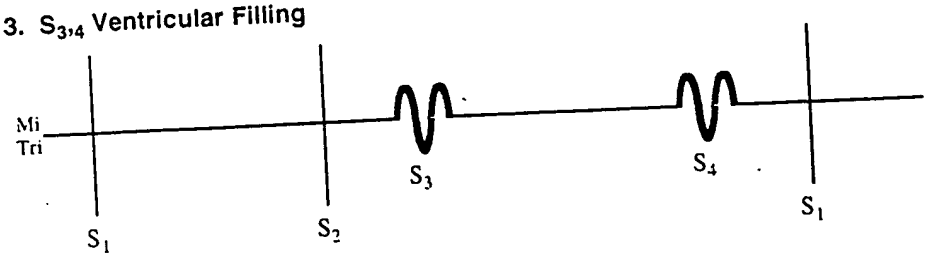
1. $S_{1,2}$ Valve closure and splitting



2. Abnormal Valve Opening



3. $S_{3,4}$ Ventricular Filling



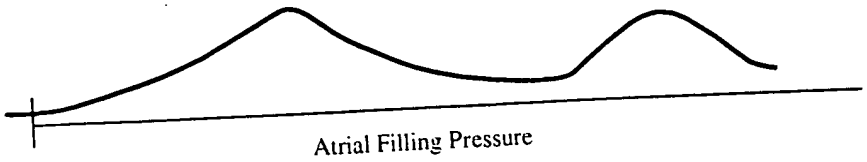


FIG. 13

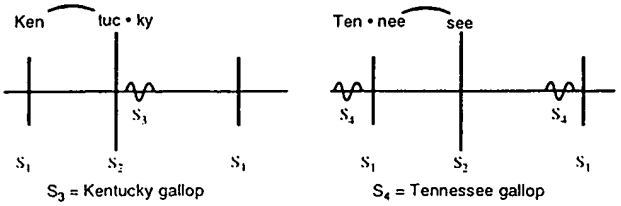


FIG. 14

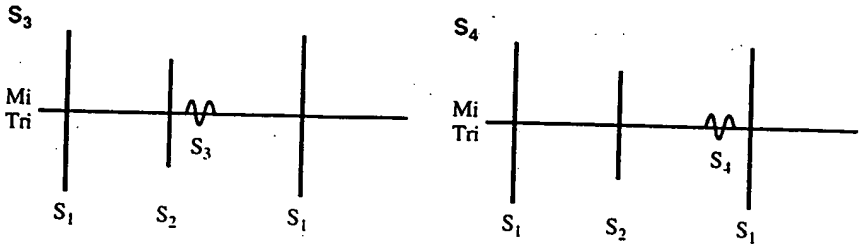


FIG. 15

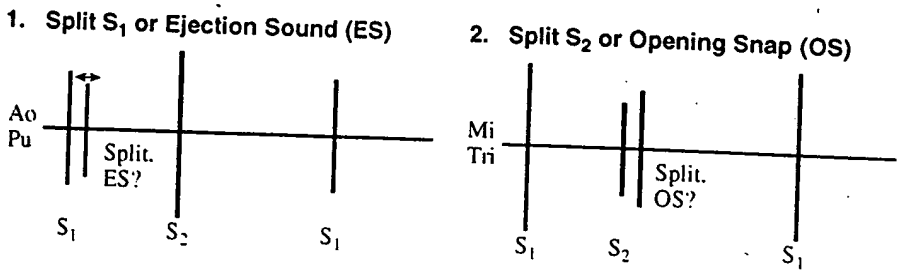


FIG. 16

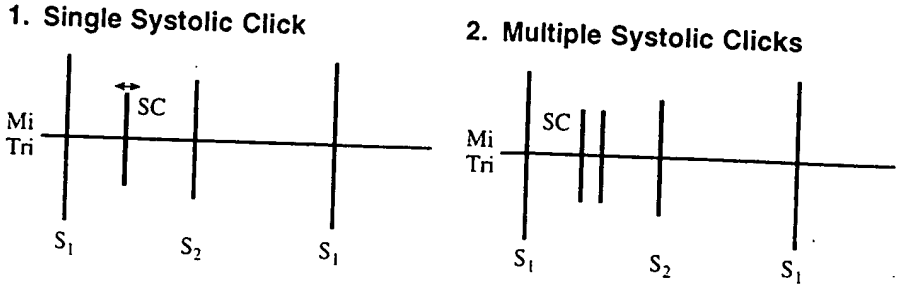


FIG. 17

Generation of S_3 and S_4

A Normal filling of ventricles does not cause displacement and diastole is silent.

B Excess velocity of blood early in filling may "shove" the ventricle longitudinally causing oscillation (dotted lines) and an S_3, in some normals. Excess blood flow may cause a *physiologic* S_3.

C A stiff ventricle may be longitudinally displaced by normal filling. This usually produces an S_4 but an S_3 may be present.

D A volume overloaded ventricle may be displaced and usually produces an S_3 but may produce an S_4.

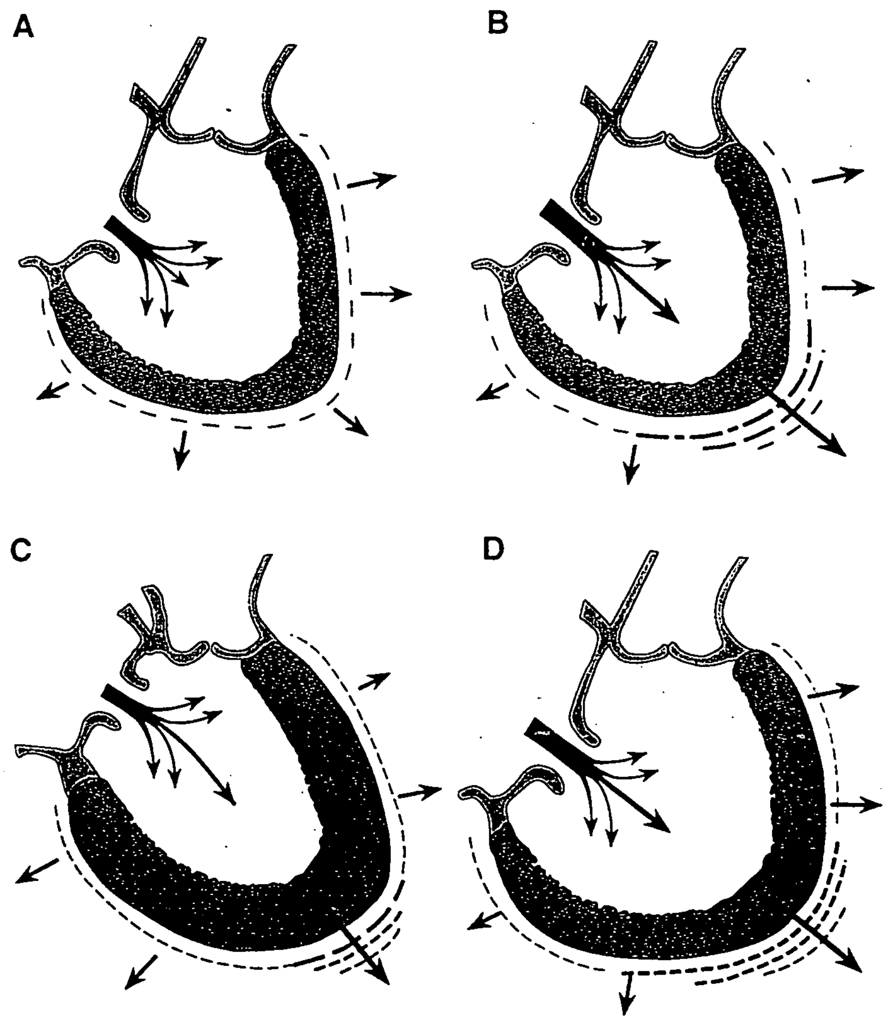
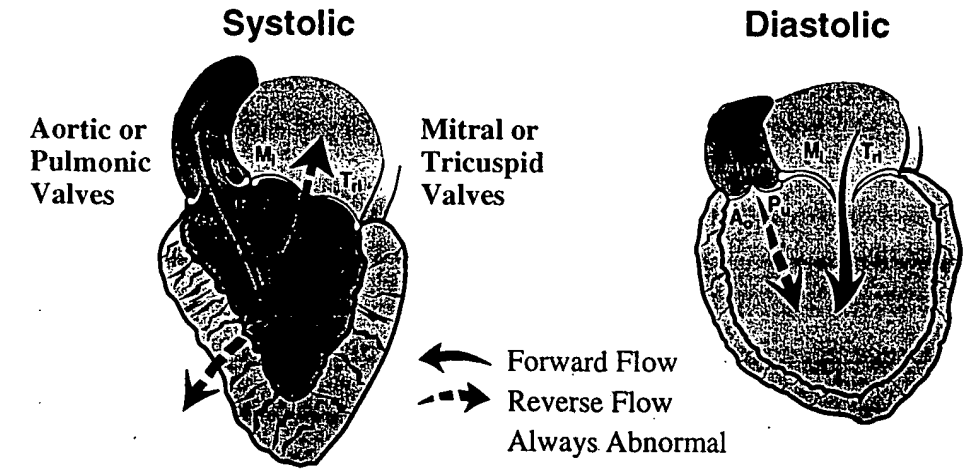
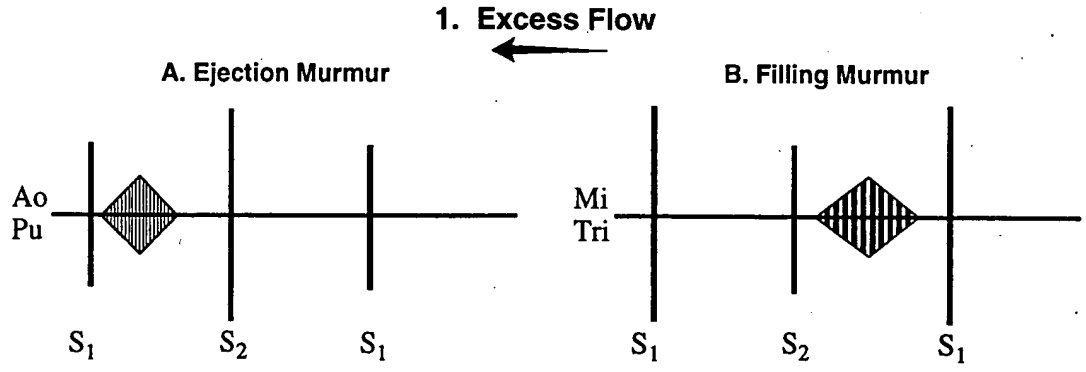
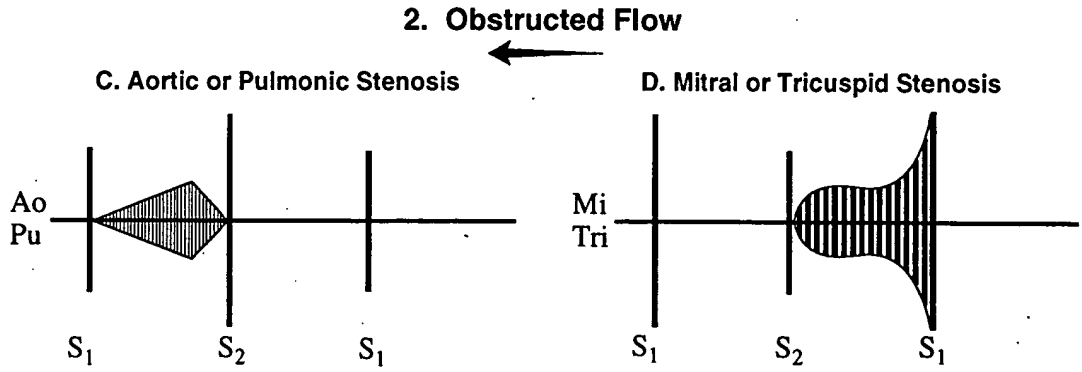


FIG. 18

Basic Cardiac Murmurs (Right or Left Ventricle)







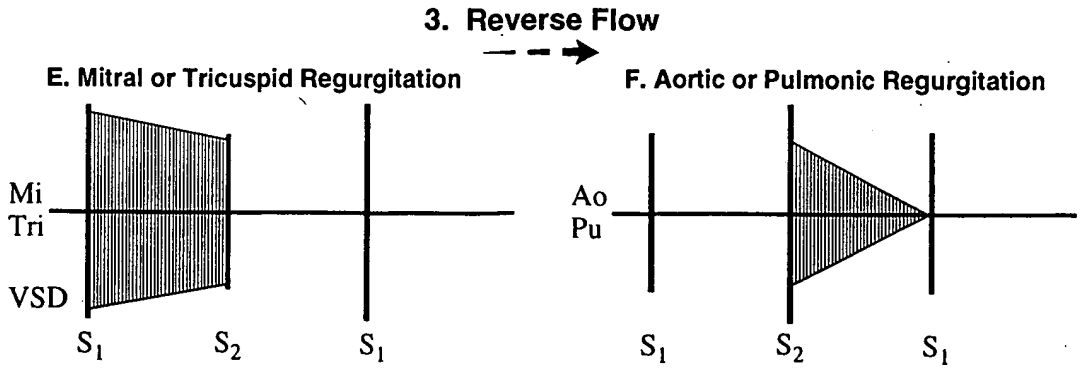
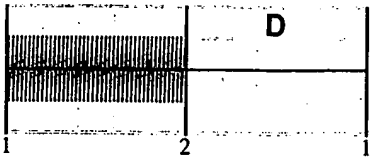
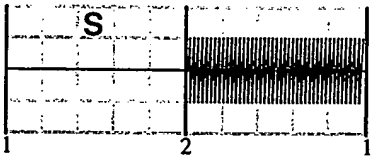
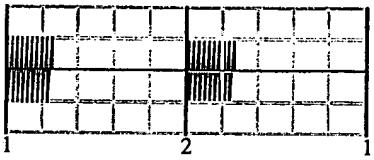
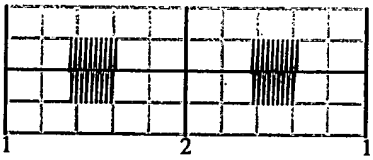
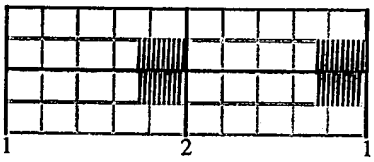
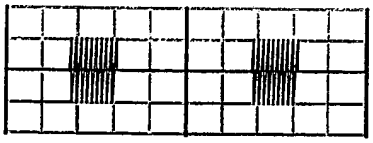
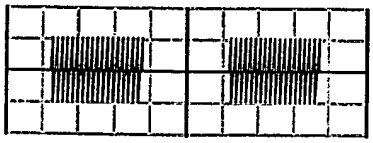
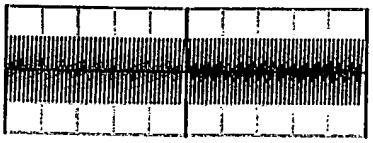


FIG. 19

Diagrammatic and Descriptive Features of Heart Sounds/Murmurs

Diagram	Description
Timing: Interval	
	Systolic
	Diastolic
Location in Interval	
	Early
	Mid
	Late
Duration	
	Short ("brief")
	Long
	Pan or Holo (entire interval)

Note: "Pre-" and "Post" are closely associated with another event; e.g., pre systolic

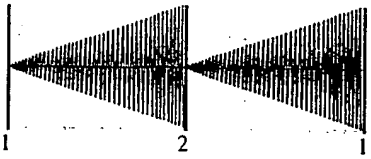
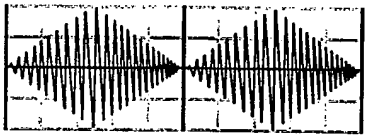
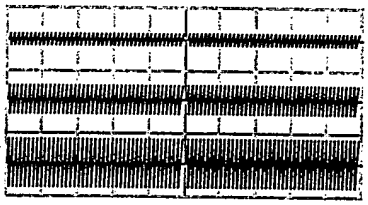
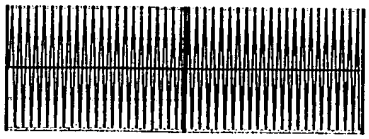
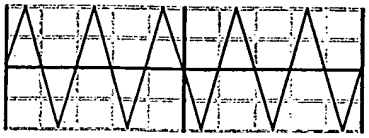
Diagram	Description
Shape: (Independent of duration)	
	Crescendo (rising)
	Decrescendo
	Crescendo, Decrescendo "Diamond Shaped, triangular"
Amplitude: (intensity)	
	Grade: 1 – barely audible 2 – audible 3 – moderately loud 4 – loud 5 – very loud 6 – heard without stethoscope, may be palpable
Pitch: (frequency)	
	High
	Low
Quality: NA	"Blowing," "soft," "quiet," "cooing," "machinery," "rumble," etc.
Location, variation with respiration: NA	Describe where loudest, radiation

FIG. 20

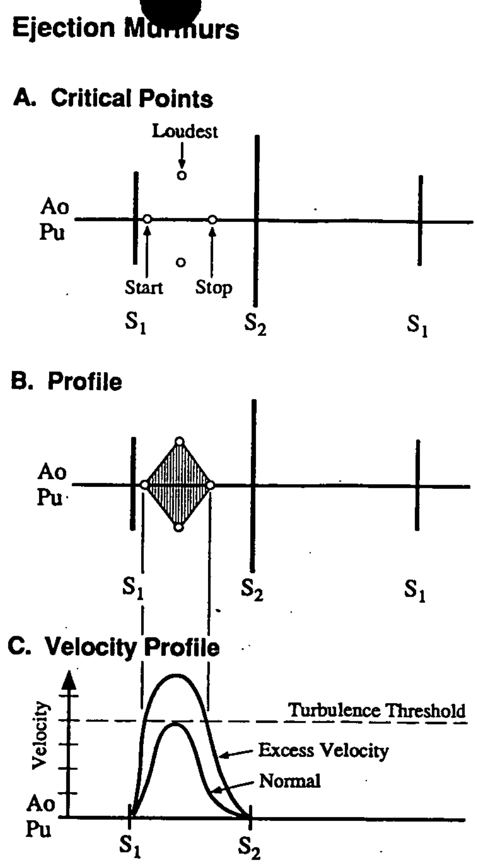

Ejection Murmurs
A. Critical Points
Loudest
Ao
Pu
Start
Stop
S_1
S_2
S_1
B. Profile
Ao
Pu
S_1
S_2
S_1
C. Velocity Profile
Velocity
Turbulence Threshold
Excess Velocity
Normal
Ao
Pu
S_1
S_2

FIG. 21

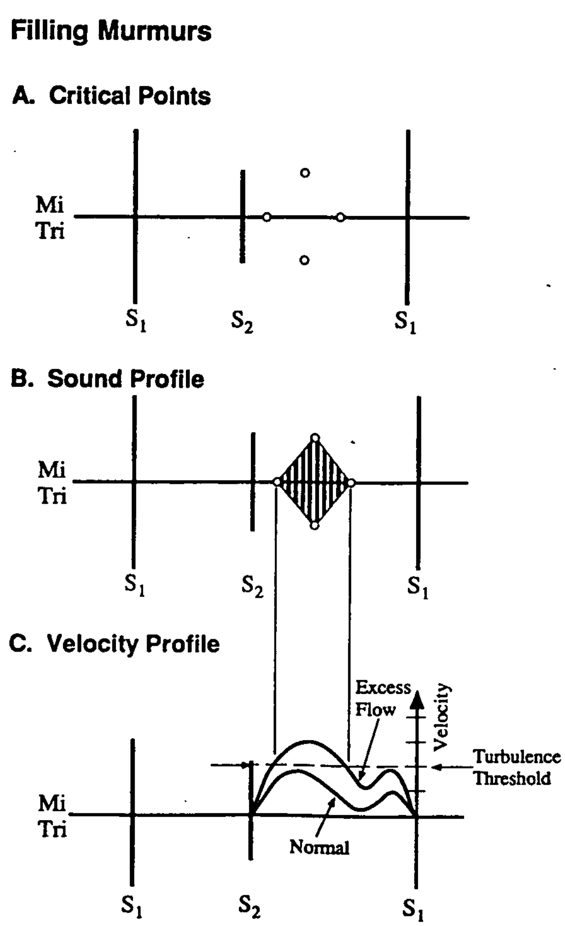

Filling Murmurs
A. Critical Points
Mi
Tri
S_1
S_2
S_1
B. Sound Profile
Mi
Tri
S_1
S_2
S_1
C. Velocity Profile
Excess
Flow
Velocity
Turbulence
Threshold
Mi
Tri
Normal
S_1
S_2
S_1

FIG. 22

Velocity vs. Area – Constant Flow

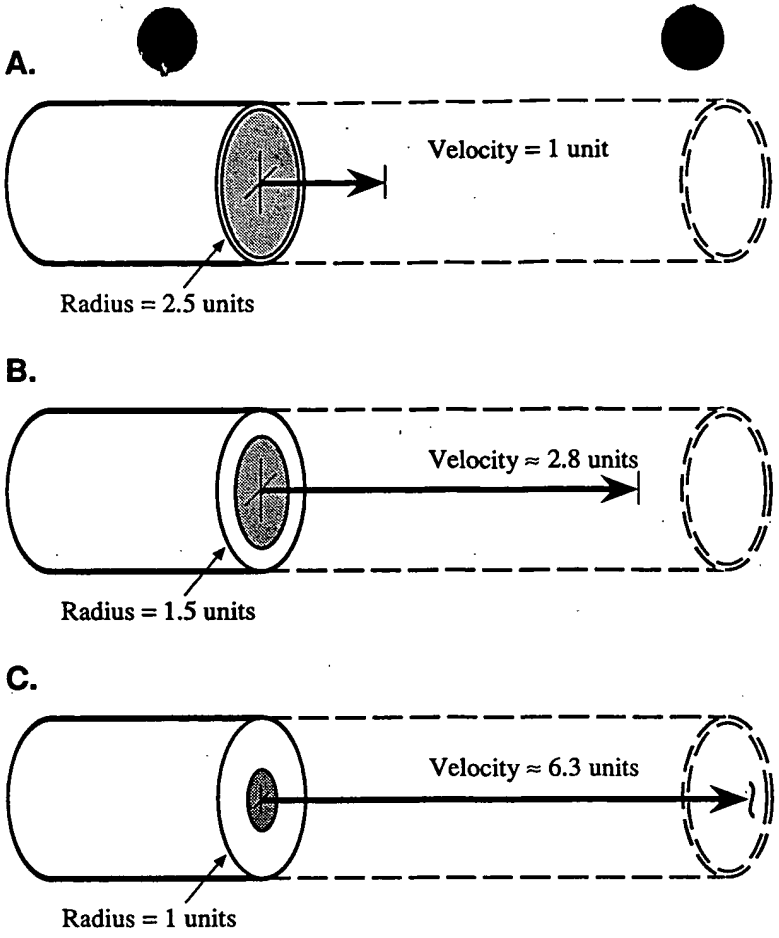
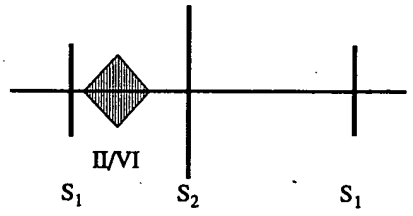


FIG. 23

Peripheral Murmurs – *Bruits, Soufflés, etc.*

A. Right Carotid



B. Left Carotid

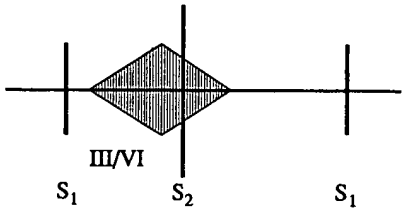
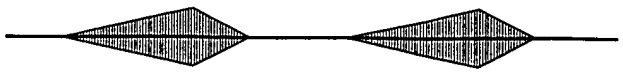


FIG. 24

C. Abdomen



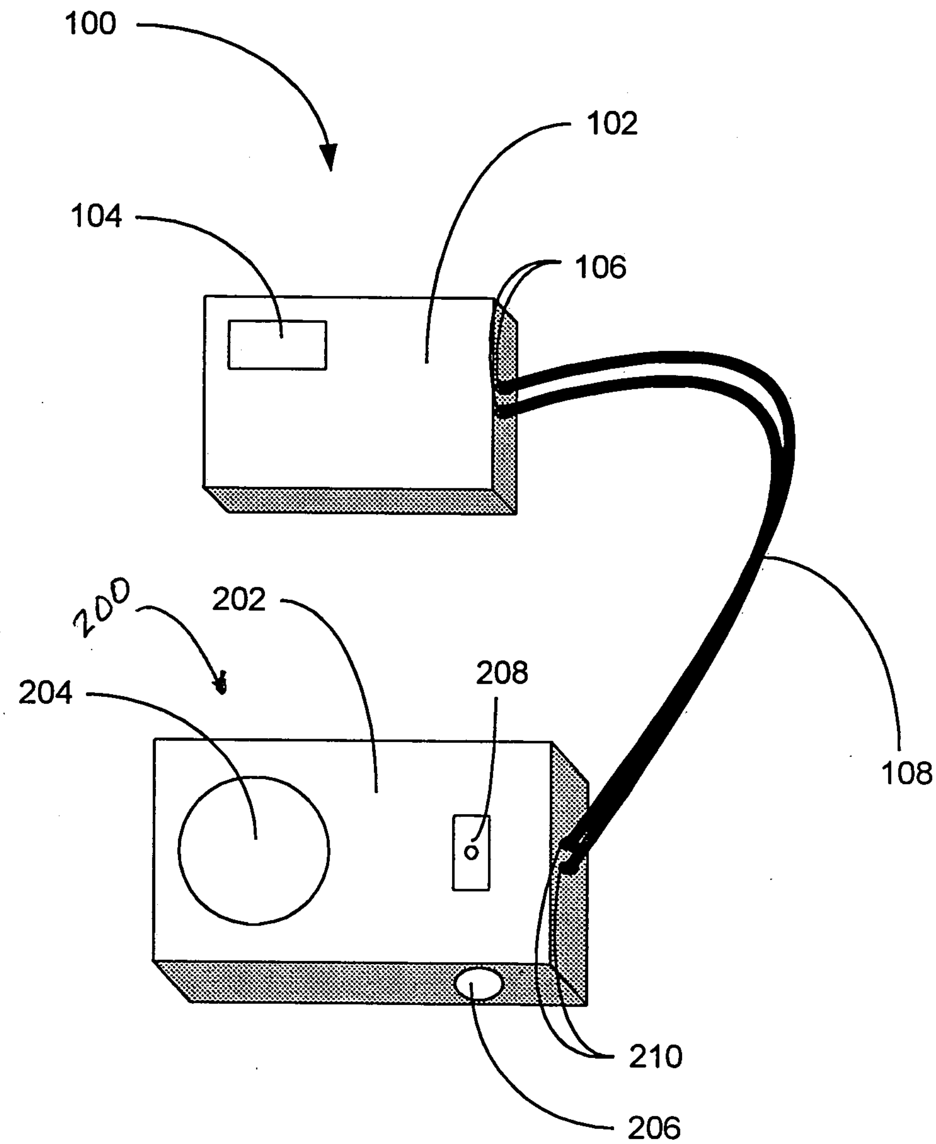


FIG. 15

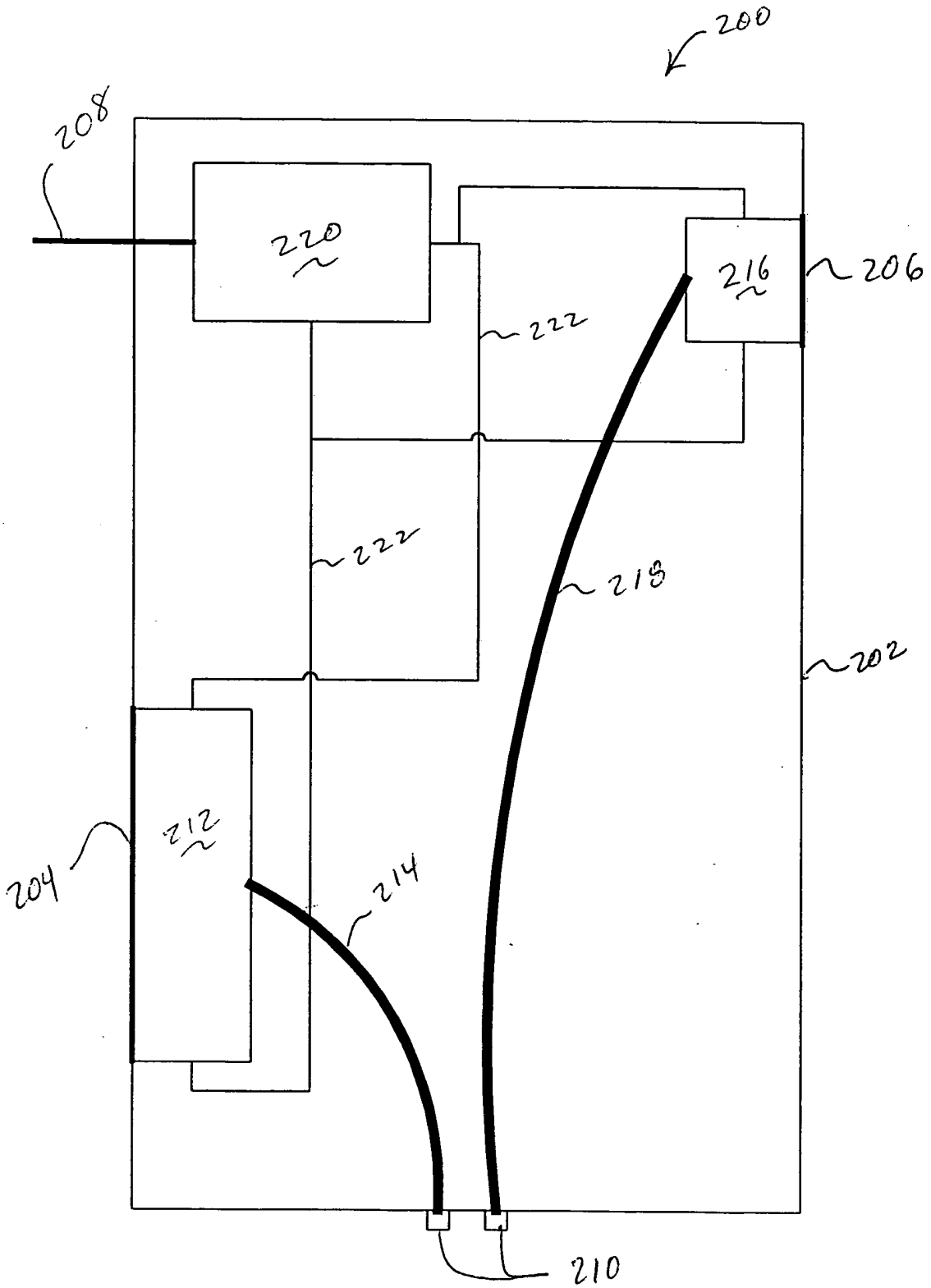


FIG. 26

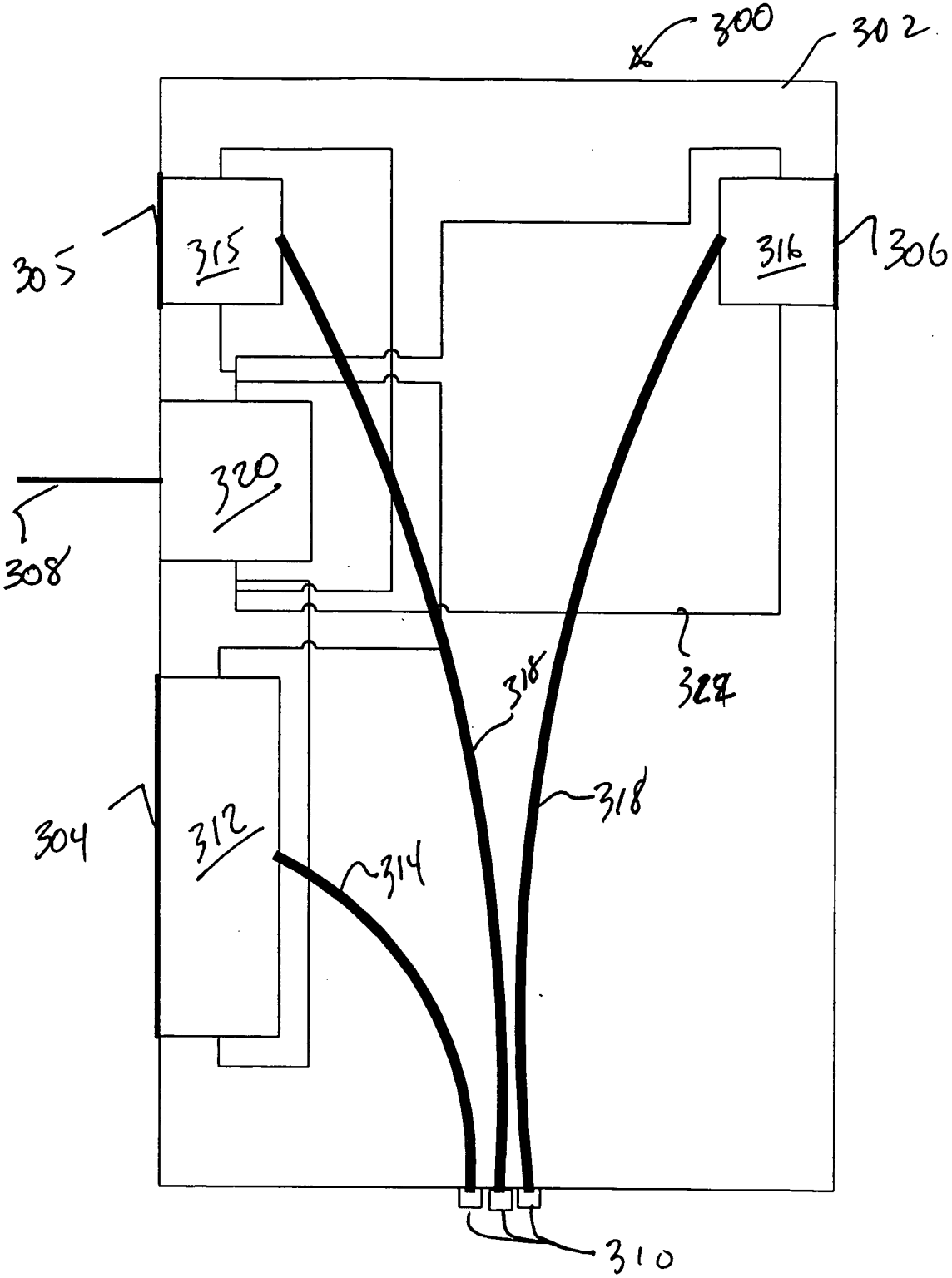
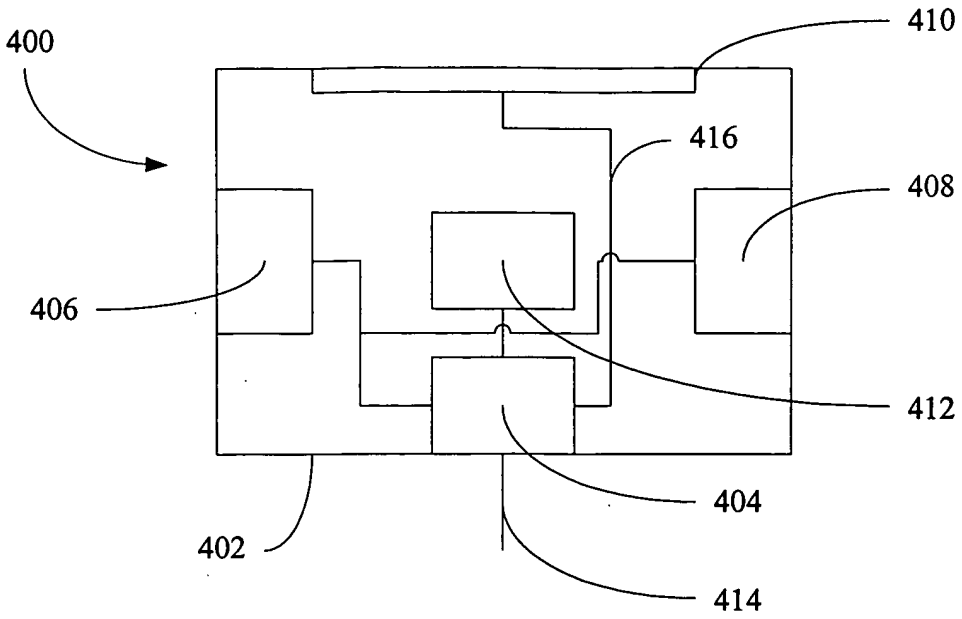


FIG. 27


400
410
416
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402
414

FIG. 29

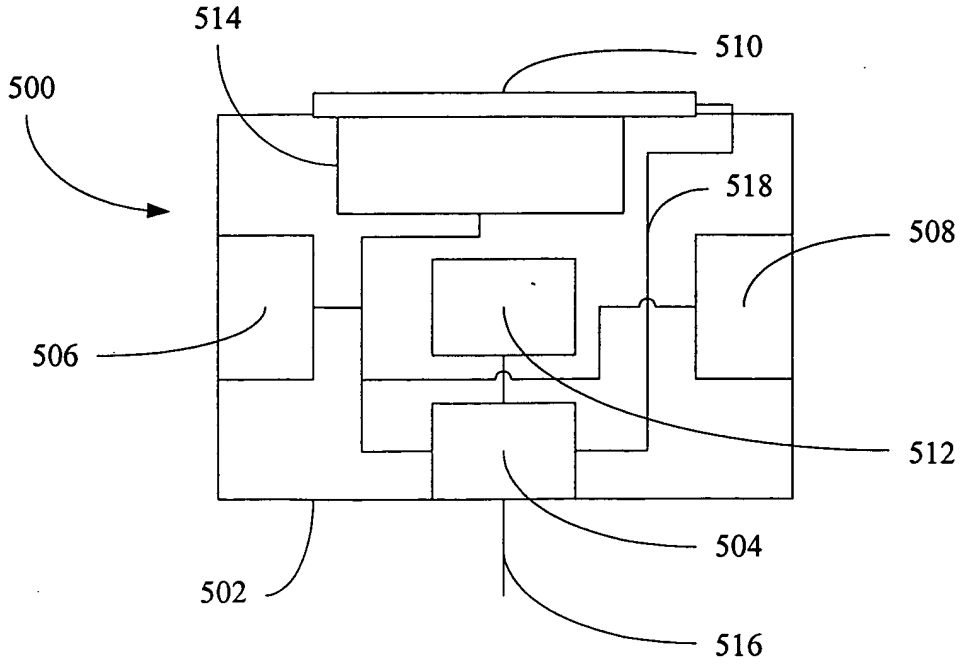

514
510
500
518
508
506
512
504
502
516

FIG. 30

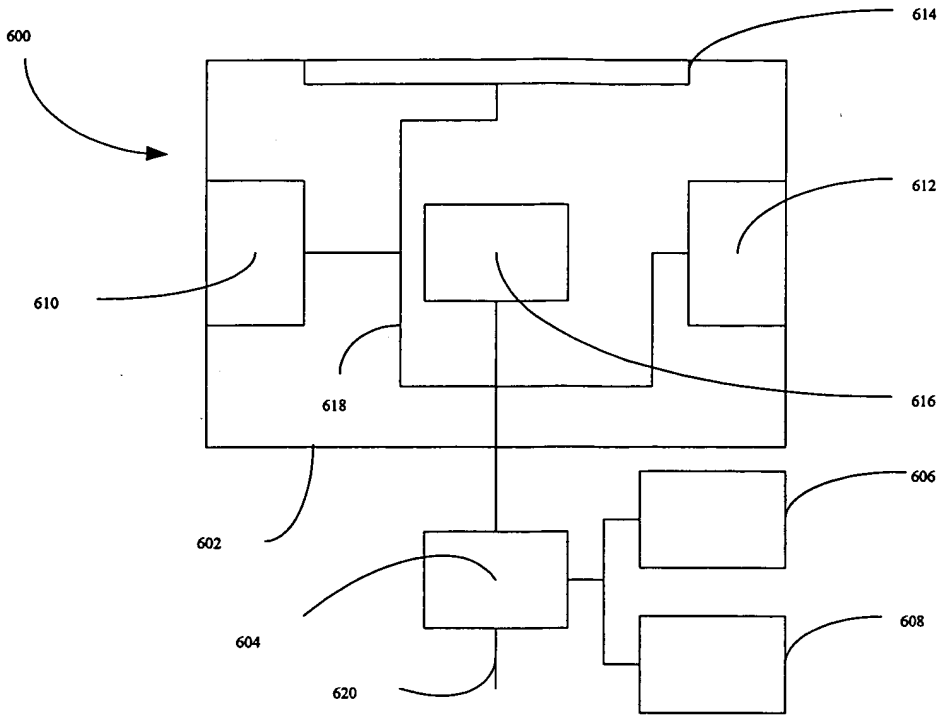
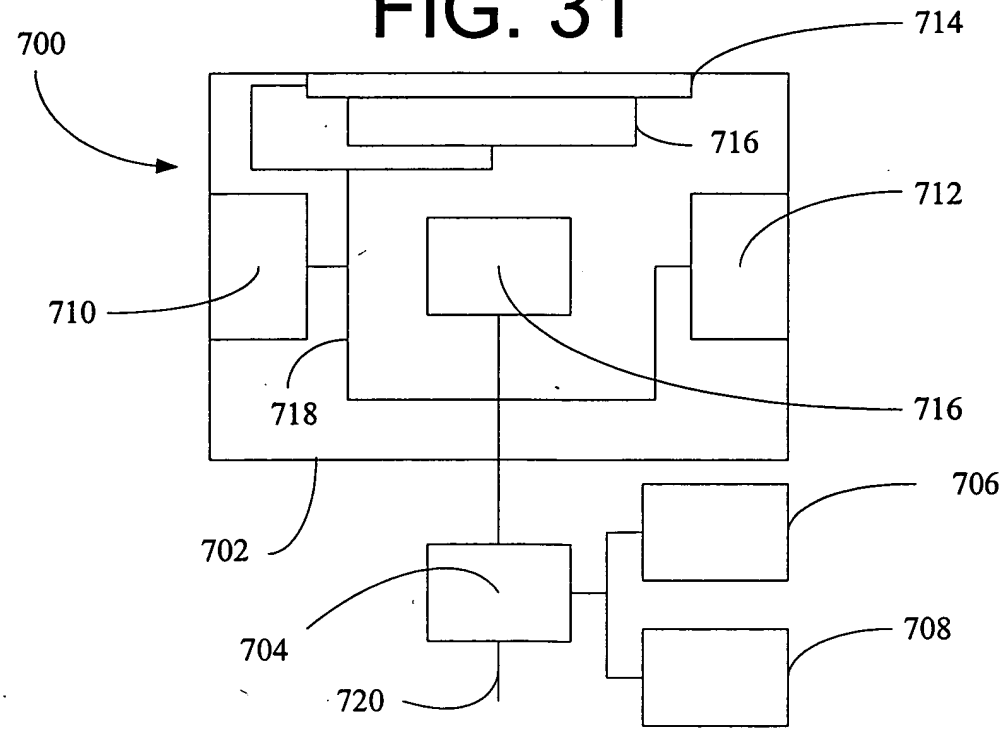

600
614
612
610
618
616
606
602
604
608
620

FIG. 31


700
714
716
712
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716
706
702
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708
720

FIG. 32